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Association between dietary carbohydrates intake, diabetes, obesity and breast cancer incidence among Sudanese women at the national cancer institute, Gezira State, Sudan (2021-2022)

Ghada Tajelsir M Abdoun [1], Nahla Hussien M. A Ataalmnan [2], Moawya I. Yousif [2], Tajelsir S.Osman [3] and Sawsan A. Omer [4, 5, *]

[1] *Department of Biochemistry and nutrition, Faculty of Medicine, University of Gezira (FOMUOG), Sudan.*
[2] *Department of Human Nutrition, Faculty of Agriculture, University of Gezira, Sudan.*
[3] *Medical student, Semester 5, Batch 43, FOMUOG, Sudan.*
[4] *Department of Medicine, FOMUOG, Sudan.*
[5] *Centre of Non-Communicable diseases, Department of Medicine, FOMUOG, Sudan.*

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Abstract

Breast cancer (BC) is the most common type of cancer and the main cause of death among women in Sudan. BC incidence rates is increasing in Sudan as estimate by the National Cancer Institute (NCI) in Wad Madani. This study aimed to investigate the relationship between high carbohydrate intake, diabetes obesity and risk of breast cancer. It was a cross-sectional study conducted in the NCI in Wad Madani, Gezira state in Sudan, during the period of 2021-2022, among 100 Sudanese women (ages: 20-75 years) who were confirmed to have BC. Data was collected by questionnaire consisted of questions about food intake and questions about BC risk factors. Physical measurements (height, weight and waist circumference) were taken. Laboratory tests (blood glucose) were done. Statistical analysis was performed by using SPSS version 22. The results showed that carbohydrate intake was positively associated with the risk of BC ($p<0.05$), and this association was higher in premenopausal women. Among carbohydrate components, the highest association were observed with sucrose and starch. BMI, waist circumference and diabetes mellitus were positively associated with the risk of BC. There was no association between age and BC ($p>0.05$). There was a very well correlation between consuming more than 30 grams per day of sugar (sucrose) and BC ($r>0.50$) while total sugar intake and carbohydrate intake had the lower correlation (0.433, 0.269), respectively ($r<0.50$). It was concluded that increased intake of foods rich in carbohydrates, especially sucrose and starch was directly associated with the risk of BC and its advanced stage in premenopausal Sudanese women. On the other hand, an increase in both waist circumference, body mass index and diabetes were positively associated with increased risk of BC.

Keywords: Breast cancer; Carbohydrates Intake; Diabetes; Obesity; Sudanese women

1. Introduction

Cancer is one of the leading causes of death worldwide. It is estimated that the global cancer burden will even grow more in the future and will reach 21.4 million new cases and 13.2 million deaths by 2030 (1). According to a projection of the World Health Organization (WHO), cancer is considered as the second cause of death in developing countries (10.4%), whereas it is the first cause of death in developed countries (26.6%) (2). Breast cancer (BC) is the most common form of cancer and the leading cause of cancer death among women in Sudan, a northeastern Sub-Saharan African country that used to be the largest country in Africa until 2011, when South Sudan detached into an independent country (3). The age-standardized incidence rate of 27.8 per 100000 and 25.1 per100000 was estimated among

* Corresponding author: Sawsan A. Omer

Sudanese women (4). Unfortunately, the majority of patients present with advanced stage disease that is not responsive to treatment. This is due to several reasons including lack of awareness, poverty, insufficiency of medical facilities and the distances from medical care facilities and the use of local healers' treatment. Breast cancer in African women's is characterized by younger age at onset, advanced stage at diagnosis, and consequently poor prognosis (5). A healthy diet may help prevent cancer and is one in which macronutrients are consumed in appropriate proportions to support vital and physiological needs without being over-consumed while providing adequate micronutrients and hydration to meet the body's physiological needs for macronutrients (i.e. carbohydrates, proteins and fats) that provide the necessary energy. Carbohydrates are one of the three main food groups and constitute about 45-65% of the total daily calories. They are made up of carbon, hydrogen and oxygen. Carbohydrates were classification to molecular or Degree of Polymerization (DP) groups carbohydrates into monosaccharides, disaccharides, oligosaccharides, and polysaccharides (6). The main monosaccharide is glucose, which is utilized as an energy source by animals. Glucose can be derived from starch and sugars in the diet, from glycogen that is stored in the body. High consumption of carbohydrates leads to an increase in the body mass index (7)**.** Dietary factors are recognized as having a significant effect on the risk of cancers, with different dietary elements both increasing and reducing risk. Diet and obesity may be related to up to 30–35% of cancer deaths (8). While physical inactivity appears to be related to 7% risk of cancer occurrence (9). Wicki *et al.* in 2011, suggested that total caloric intake influences cancer incidence and possibly progression. While many dietary recommendations have been proposed to reduce the risk of cancer, few have significant supporting scientific evidence. Obesity and drinking alcohol have been correlated with the incidence and progression of some cancers (10). Lowering the drinking of beverages sweetened with sugar is recommended as a measure to address obesity (11). A diet low in fruits and vegetables and high in red meat has been implicated but not confirmed (12). And the effect may be small for well-nourished people who maintain a healthy weight (10). Some specific foods are linked to specific cancers. Some studies have linked eating red or processed meat to an increased risk of breast cancer, colon cancer, prostate cancer and pancreatic cancer, which may be partially explained by the presence of carcinogens in foods cooked at high temperatures (13). Ferguson *et al.,* 2010, reported that aflatoxin B1, a frequent food contaminant, increases risk of liver cancer. Recently, the association of dietary carbohydrate intake with breast cancer risk has received a significant amount of attention based on the hypothesis that a high dietary carbohydrate intake increases insulin resistance and increases plasma concentrations of insulin—conditions that may be associated with breast cancer risk (14). The specific composition of dietary carbohydrates consumed may be particularly important in breast cancer risk. Consumption of high-glycemic-index foods was associated with higher postprandial or fasting plasma insulin concentrations (15, 16). Some case-control studies (17,18) and a prospective study have reported that high-glycemic-index foods may be associated with an increased risk of breast cancer (19). Cancer prevention typically includes weight management and eating vegetables, fruit, whole grains and fish, and to reduce intake of red meat, animal fat, and refined sugar (10). BC is the most common type of cancer that cause death among women in Sudan. Due to the increase in the incidence of breast cancer among women in Sudan and only few studies in this field were conducted, this study was an initial step for studying the nutritional causes that may lead to BC, since there is high consumption of carbohydrates in the diet of Sudanese women. This study aimed to **s**tudy the association between high carbohydrate intake, diabetes and obesity, and breast cancer incidence among Sudanese women at the National Cancer Institute, Gezira State, Sudan (2021-2022).

2. Materials and methods

Participants were enrolled in a cross-sectional study to evaluate the association between high carbohydrate intake, diabetes, obesity, and breast cancer incidence among Sudanese women aged 20 to 75 years. All cases who matched the study specifications and who were confirmed to have breast cancer at the National Cancer Institute(NCI) in Wad Madani in the period 2021-2022 were selected. Cases suffering from any other type of cancer before being diagnosed with breast cancer, cases with a family history of the disease, and cases who used alcohol, tobacco, and smoking before being diagnosed with breast cancer were excluded.

A questionnaire was administered about potential risk factors for breast cancer, and the cases were interviewed at the clinics of the NCI in Wad Madani after confirming the incidence of breast cancer. The questions were asked in the local language, the questionnaire consisted of four pages, and it was filled within 15 minutes from each patient. The questionnaire consisted of a food frequency questionnaire to determine the frequency of patients' intake of each food item eaten on a daily, weekly or monthly basis up to the previous year, through a personal interview with patients. It also included questions about habits, lifestyle, medical history, physical activity, dietary pattern, and family history of disease. Food frequency questionnaires were used to determine the amount and type of carbohydrate intake for each food. A commonly used unit or volume is specified (a specific volume, a slice, a cup, or a natural unit such as one apple).

A group of 100 women agreed to participate in the questionnaire and provided nutritional information about their dietary pattern for a previous year and physical measurements (height, weight, and waist circumference) were taken.

- **Energy calculation:** The energy intake from carbohydrates was calculated using the Mifflin- St Jeor equation to calculate the calories (basal metabolic rate) that the body needs per day in calories. The Mifflin-St Jeor equation, created in the 1990s, provided an alternative and more valid estimate of resting metabolic rate (RMR) (20). several factors on which the amount of calories depends were considered ,mainly (age, height, weight and gender).The Mifflin- St Jeor equation for females = (10 × weight in kg) + (6.25 × height in cm) - (5 × age in years) – 161.

Total calories = basal metabolic rate X physical activity index.

Total calories were divided by two to determine the total calories consumed from carbohydrates, and compared to the total amount of carbohydrates eaten in each case, by multiplying the carbohydrate content (in grams) of each specific food item per day by the calories per gram of carbohydrate (1 gram = 4 calories).

- **Anthropometric measurement:** Weight and height were taken using a device that measures height and weight together (the Detecto scale) to obtain a body mass index (BMI) is a method of using the height and weight of an adult to place on a scale a normal weight for an underweight person. categories of overweight and obesity. BMI can be calculated using metric or imperial (US) units.
- **Metric units**: weight (kilograms) divided by height squared (meters)

BMI = kg/m^2

The current cut-off points of BMI as determined by the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) (21). Overweight: 25.0 - 29.9 kg/m^2, Moderately Obese: 30.0 - 34.9 kg/m^2. Severely Obese: 35.0 - 39.9 kg/m^2. Morbidly Obese: greater than or equal to 40.0 kg/m^2(*21*)

Waist circumference was measured using a tape measure for cases that agreed to participate in the questionnaire.

- **Laboratory tests:** Blood sugar was measured laboratory using a glucometer for the cases that agreed to participate in the questionnaire. The normal level of blood glucose during fasting is between 70 and 100 mg/dL , normal level for a random sample depends on when you last ate. Most often, the blood glucose level is 125 mg/dL or less (22).

2.1 Statistical analysis

Caloric intake was individually calculated for carbohydrate needs and compared to calories consumed for each condition, and differences between individuals' means were determined by Chi-square test, t-test, correlation. All statistical analyzes were performed using the statistical program SPSS version 22 (Statistical Package for the Social Sciences).

2.2 Ethical consideration

Ethical clearance from the faculty of Medicine University of Gezira ethical committee was obtained. Verbal consent was obtained from each person.

3. Results and discussion

3.1 Age and incidence of breast cancer

In this study the majority of breast cancer patients 55 (55%) were diagnosed at the age group between 20-45 years. 40 (40%) at the age group 45-65 years and 5 (5%) at the age group 65-75 years. However, age group was not significantly ($p>0.05$) associated with breast cancer development. *Al-Awwad*, *et al.* (2013) reported on a study conducted in Sudan, that locally advanced BC in Sudan is a disease that affects young women especially at the premenopausal period (23).

3.2 Sugar intake and risk of breast cancer

The demographic results showed that the percentage of women who consumed more than 10 percent of their daily calories from sucrose and added sugars was (83%) compared to the rest of studied group (17%). These data indicate a strong association between sucrose and the risk of breast cancer. There were statistically significant differences ($P<0.05$) between high sugar intake and the development of breast cancer (chi-square test; $p = 0.033$) (Table 1). These findings are consistent with a study of Mexican women's done by Romieu *et al.* (2004), a positive association was

observed between carbohydrate intake and the risk of BC (34). The strongest association was observed with regard to sucrose intake. Bradshaw *et al.* (2009) reported that higher consumption of sweet foods, especially sweets, may be positively associated with breast cancer risk, and the effect may be more pronounced among women who are thinner and more physically active (35). The implication of these findings may lead to greatest reduction in B.C risk by doing regular physical activity and maintaining a healthy weight along with a diet low in sweets and sweets. These findings provide further evidence for a role of insulin in breast carcinogenesis. In addition to acting as a tumor inducer per se, insulin increases the activity of insulin-like growth factor I (IGF-I), which also acts as a tumor promoter.

Table 1 Sugar intake and risk of breast cancer

Sugar intake	Percent	p- value, sig Chi-square
<30g per day	17.0	0.033
>30g per day	83.0	
Total	100.0	

3.3 Diabetes and the risk of breast cancer

In the present study demographic data, percentage of women with type II diabetes was 13%, there was a statistically significant relationship ($p<0.05$) between diabetes type II and development of BC (chi square test; $p = 0.038$) were shown in (Table 2). According to Liao *et al*., (2011), diabetes could be considered as a risk factor for BC development (24). In addition, the state of the menstrual cycle and geographic distribution can affect the relationship. Peairs*, et al*. (2011) reported that diabetes affects up to a third of patients with breast cancer and evidence suggests that women with diabetes have a 40% higher risk of dying after breast cancer than women without diabetes (25). Zhao *et al*., (*2016*) reported cancer prognosis may also be affected by health care disparities in people with diabetes (26). In fact, some studies showed that women with diabetes have lower screening rates for breast cancer (27). Further studies are necessary to verify these findings to clarify the relationship between diabetes and BC risk.

Table 2 Diabetes and the risk of breast cancer

Diabetes	Percent (%)	p- value, sig Chi-square
No	87.0	0.038
Yes	13.0	
Total	100.0	

3.4 Body mass index (BMI) and breast cancer risk

The results of the current study showed statistically significant relationship ($p < 0.05$) between over-weight and BC development (chi-square test; $p = 0.029$). The BC patients with a BMI higher than 25 kg/m² was (55%) compared to (45%) to the rest of the group. In this study, a higher BMI was associated with advanced stage of BC at diagnosis. These results were consistent with those of many previous studies. Jones et al. (1997) reported that women aged 26–79 years and severe obesity was significantly associated with tumor node metastasis (TNM) stage at diagnosis. Hall et.al. (1999) reported that among young women (aged 20–44 years), a positive association between high BMI and advanced stage at diagnosis was found (28,29). In a study of Chinese women's done by Liu *et al.* (2018) reported that every 5 kg/m² increase in BMI, there is a 2% increase in the risk of developing BC in women (30). However, it could be BMI is the highest protective factor for BC risk in premenopausal women. Further studies are necessary to verify these findings to clarify risk factors for the disease.

3.5 Waist circumference (WC) and breast cancer risk

The current study showed that women with WC > 88 cm were (61%) compared to (39%) of the studied group. There was statistical significant variation (P=0.05) between WC and risk of BC (Table 3). This finding is consistent with a study of Korean women by Lee et al. (2017), who reported that body mass index and WC were closely associated with the risk of BC (31). Huang et al. (1999) indicated that an increased waist circumference increases the risk of breast cancer, especially among postmenopausal women who would otherwise be at lower risk due to not using estrogen replacement hormones (32). In a study by Wisse et al. (2018), preoperative anthropometric examinations in breast cancer patients were evaluated and examined in relation to clinical outcomes (33). Breast size was the strongest prognostic and

prognostic factor associated with breast cancer-free interval. Body mass index and waist circumference were the strongest prognostic factors.

Table 3 Waist circumference and breast cancer risk

WC/cm	Percent (%)	p- value, sig Chi-square
<88cm	39.0	0.05
>88cm	61.0	
Total	100.0	

4. Conclusion

It was concluded from this study that increased intake of foods rich in carbohydrates, especially sucrose, starch was directly associated with the risk of BC and its advanced stage in premenopausal Sudanese women. It was also found that low intake of vegetables and fruits was closely related to the risk of BC. On the other hand, an increase in both waist circumference and body mass index were positively associated with the risk of BC stages. Diabetes was also positively associated with risk of BC. Based on these findings, reducing the intake of foods rich in carbohydrates, especially refined grains, added sugar (sucrose) should be recommended. Eating of whole grains, legumes (beans, lentils, and dried peas), vegetables, and fruits should be encouraged.

Compliance with ethical standards

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Disclosure of conflict of interest

All authors have no confilict of interest.

Statement of ethical approval

Ethical clearance from the faculty of Medicine University of Gezira ethical committee was obtained.

Statement of informed consent

Verbal consent was obtained from all individual participants included in the study.

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